

ANNALS  
OF  
The Entomological Society of America

---

Volume XV

DECEMBER, 1922

Number 4

---

NOTES ON FEMALE PARAIULIDS  
(Myriapods), with Description of a New Species.

HENRY W. BROLEMANN,  
Pau (France).

The material submitted to examination is composed of two species of *Paeromopus* and of six representatives of the genus *Paraiulus*. Of the two *Paeromopus*, one is the well known *P. lysioptalinus* Karsch, while the other, being new to science, will be spoken of as *Paeromopus Chamberlini* and will be described hereafter. The *Paraiulus* species are *P. tiganus* Chamb., *P. pennsylvanicus* (Brandt) Wood, *P. immaculatus* Wood, *P. impressus* Say, *P. venustus* Wood, and the species recorded by the author (1895) as *P. ellipticus* Bollman. Most of the *Paraiulus* specimens have been obtained through the kindness of Ralph V. Chamberlin, of the Museum of Comparative Zoology, in Cambridge, to whom the writer wishes to express herewith his indebtedness.

It may safely be stated that, on the whole, the study of female Diplopods, and particularly of their sexual organs, has been completely neglected, attention having been almost exclusively devoted to the male copulatory apparatus. H. C. Wood (1865, Trans. Amer. Phil. Soc., XIII) is probably the first author having made use of the vulvæ in identifying Paraiulid species.

The distrust in which the females have been held is probably due to the fact that the male structures happened to be so multifarious and of such constancy as to afford the easiest

and most reliable means of identification of the species, while on the other hand the vulvæ appeared less manifold and did not supply equally favorable criteria. Another reason lies in this, that the vulvæ have long remained a mystery.

Since 1909 (Sitzb. Ges. naturf. Freunde Berlin, 1909, No. 4), Verhoeff claimed to have settled the matter by holding that the vulvæ—as well as the penis—had to be identified with pairs of limbs. These were supposed to be the posterior limbs of the third segment, which the author admitted to be

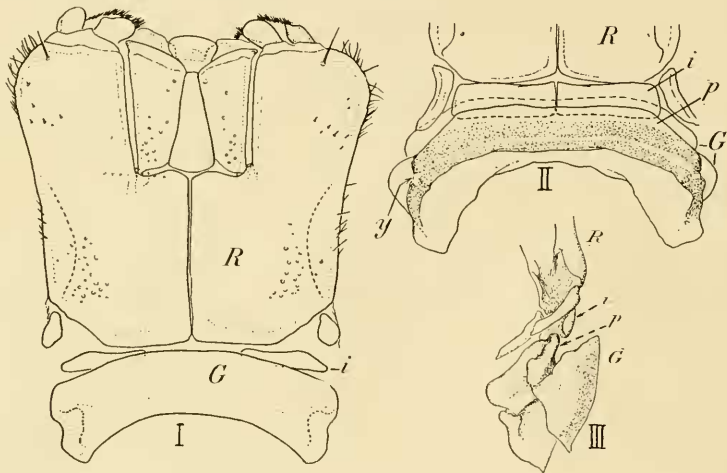


Fig. I. *Paeromopus lysiopetalinus*; gnathochilarium, ventral aspect.

Fig. II. *Paraiulus tiganus*. Base of gnathochilarium of adult female, dorsal aspect. The postmentum, *p*, is fastened to the gula, *G*, along the line left blank, *y*.

Fig. III. • *Paraiulus venustus*. Base of gnathochilarium of adult female seen obliquely from the side.

double, as the abdominal segments. It was in fact but a mere personal view, supported by no convincing reasons, and has been contradicted by Brolemann & Lichtenstein (1919, Arch. Zool. exper. gen., LVIII, fasc. 4, mars, 1919), who admit that the so-called vulvæ are not the equivalent of limbs, but are merely superficial differentiations of the membrane surrounding the aperture of the oviduct.

It is not deemed appropriate to recall in this paper the reasons which have prompted the opinions here recorded. Yet it will not be useless, in order to render the task easier

to readers of the following descriptions, to draw an elementary sketch of a vulva and to make them acquainted with the terms which have been applied to the different parts of these puzzling organs.

The two branches of the oviduct are known to end behind the legs of the second pair and to be capped with vulvæ. In most of the Diplopod groups (*Colobognatha* and *Oniscomorpha* excepted), the vulvæ are concealed in a deep depression of the intersegmental membrane, which will be known as the vulvar "vestibulum." In some cases the vulvæ stand side by side in the vestibulum, while in some others they are sunk into independent, lateral invaginations of the vestibulum, apart from each other, (Fig. 3). The position of the vulvæ is therefore very different, according to the various cases; but whatever it may be, in order to make things obvious, a vulva is always considered isolated and standing with its free end upwards (as represented in Figs. 26 and 27, *Paraiulus pennsylvanicus*, for instance).

In condition of rest, the terminal region of the oviduct may be compared to a funnel which has been pressed flat, causing the aperture to be linear and perpendicular to the main axis of the body. Immediately behind the aperture the neighboring surface is raised into a more or less projecting and rounded, always very conspicuous jutting, called the "mound." Its lateral slopes are protected by chitinised plates, reminding one of the shells of a Lamellibranch, and consequently termed the (inner and outer) "valves," (*iv*, Fig. 26). An apical space, the "ridge," (*r*, Fig. 27), is left between the valves, made of colorless chitine, below which is to be seen a longitudinal chitinous, gutter-shaped thickening, the "apodema," (*a*), extending perpendicularly to the aperture of the oviduct. The apodematic gutter communicates with the exterior by means of a longitudinal "slit," which divides the ridge into more or less regular halves.

In some cases the posterior ends of the valves remain free, the ridge being open backwards; in the case of Iulids, the valves are generally connected by, and often fused with a posterior-median plate, the anterior margin of which is emarginate and thickened in shape of a horse-shoe ("horse-shoe plate"). The latter bounds the ridge caudad, (*h*, Fig. 27).

Further backwards, behind the mound, a plate of very variable size and form may be observed, which is known as the "shield." It is not unusually found amongst Polydesmids, Chordeumoids or Spirostreptoids, but has only been met with in a single Iuloid Diplopod, *Mesoblaniulus serrula*, and its existence in *Paeromopus* is highly interesting, (*s*, Figs. 4, 8, 9).

Cephalad the mound is fenced in by the posterior wall of the oviductal funnel; its anterior end is therefore flattened and may be spoken of as the "anterior truncation."

In front of the oviductal aperture is a more or less thickly chitinised, erected plate (*o*, Fig. 5, 26, etc.), the posterior surface of which is lined by the anterior wall of the funnel. Its outline is variable and made to fit the anterior truncation of the mound, whence the name "operculum" used for it.

As a matter of fact, the vulvæ are by no means as simple as could be inferred from the above rough sketch; but the latter will, perhaps, be sufficient from a morphological point of view, and readers interested in further details will kindly refer to Brolemann & Lichtenstein's paper of 1919. Yet a few more words have to be devoted to a structure exceptionally met with in some American species.

When the vestibulum is deep enough to conceal the vulvæ and to allow the third segment to meet the second above them, the operculum has very little importance as a protective plate (see *P. tiganus*). But when the summit of the vulva is on a level with the ventral surface, the operculum is made to shelter the mound from external contacts. For instance, in contradiction with what has been so far observed in other groups, the operculum of some of the species hereafter recorded is by far the largest plate of the vulva, the most interesting cases being those of the *Paraiuli* of the *impressus* group. In these species the vulvæ are coupled, the opercula of both vulvæ having become coalesced into an uncommonly large, tectiform plate, erected perpendicularly to the main axis of the body (*y*, Figs. 39, 46, etc.), the only trace of fusion left being a notch in the apical ridge; consequently this plate will be spoken of as a "synoperculum." The mounds are located laterally in distinct, symmetrical dimples bounded distally and inwardly by diagonal edges of the operculum, delineating between them and the apical ridge a raised, triangular or heart-shaped space,

projecting caudad ("heart-shaped projection").\* The outline of the synoperculum, the depth of its apical notch, the size of the heart-shaped projection are different in each species and supply good criteria for the identification of adult females:

Before entering into further details as to each particular case, some of the general features of the species under consideration may be mentioned. In *Paeromopus* the ventral duplicature of the mandibular stipe is short and more or less angular, while in *Paraiulus* it is produced into a rounded lobe, reaching about half the length of the cardo. Ralph V. Chamberlin has published a drawing of the gnathochilarium of a male *Paeromopus lysiopetalinus* (Ann. Entom. Soc. Amer., III, No. 4, 1910, Pl. XLIII) which agrees almost entirely with our own, except that no plates are represented between the gula† and the base of the stipes. In Californian ♂ and ♀, *P. Chamberlini*, as well as in ♀ *P. lysiopetalinus* (Fig. 1), two symmetrical narrow stripes are found, considered to represent the intermentum. However, a sexual dimorphism might account for this discrepancy and the matter has therefore to be investigated anew. The postmentum is constantly missing.

It has already been stated, 1902, that an intermentum and a postmentum exist in both sexes of *Paraiulus*. However, a detail was at that time left unmentioned, i. e., that the postmentum, which is independent in males, is fastened to the gula in females, the caudal margin of the former being fused with the dorsal concavity of the latter, as shown in Fig. II and III. In the *Blaniulidæ*, which are European representatives of the *Paraiulidi* phylum, the intermentum and the postmentum are both present, the latter always remaining independent, but being entire (*Blaniulinæ*) or divided into two plates (*Isobatinæ*). The female *P. pennsylvanicus* examined combines the two structures, as the postmentum is divided, as in *Iso-*

---

\*The origin of the "heart-shaped projection" will probably have to be sought for in the "hood" of *Paeromopus*. While in the latter it has become an almost independent plate through the effects of long lasting rectigradation, in *Paraiulus*, it has not reached the same grade of achievement owing to reasons still to be ascertained, but likely to be connected with Neotenia.

† Since his paper, 1902—Ann. Soc. Entom. France, LXXI—the author has been induced to accept the terms proposed by Verhoeff for the parts of the gnathochilarium. Consequently what was named mentum, hypostoma and ventral plate I in said paper, is now the intermentum, the postmentum and the gula.

*batinæ*, and yet is attached to the gula, as in other species of *Paraiulus*.

In female *Paraiuli*, the second segment and the third are more or less swollen in accordance with the size of the vulvæ. The second segment is generally produced ventrad, the ventral margins of the tergo-pleural arch being twisted (Fig. 12, a) and bearing the so-called ventral lobes (*l*). On the surface of the twisted part occurs a transverse "ventral ridge" (*n*), surrounding cephalad a large and shallow dimple (*u*). According to species the ventral ridge is more or less irregularly curved, the dimple resulting broader or longer. The third segment shows a still more irregular structure, as it sometimes tapers ventrally (*tiganus*), and sometimes grows longer (*impressus-venustus*); the ventral lobes may likewise be very different or much reduced.

In *Paeromopus* ( $\sigma$  and  $\varphi$ ), the ventral region of the three anterior, thoracic segments present a more simple structure, deemed to be archaic. The duplicatures of the collar lobes are more narrow and their angles are evenly rounded (not notched). No ventral lobes are found on the two following segments, the margins of which are diagonally converging backwards, the posterior angles being acute. Under contraction (Fig. 54), the three segments are forced into one another, their ventral margins uniting to build an oval frame, which is closed backwards by the sternal plate of the fourth segment, and in which fit the head with the mouth-parts, the limbs of the first and second pairs and the sexual apertures (vulvæ or penis) closely packed together. An exceptional case is likewise found in *Paeromopus*, as the sternite of the third pair of legs is not fused with the fourth tergo-pleural arch, as usual, but freely articulates with it, a condition realized in the Japanese genera *Kartëroiulus* and *Kopidoiulus*.

In all cases the limbs of the first pair remain independent and show no striking particulars; the sternite is usually missing (Fig. 2). The limbs of the second pair are preserved in *Paeromopus* (Fig. 3), and are not coalesced; the sternal plate is scarcely chitinised and only between the stigmata, which are membranous dimples; the tracheal stalks are very long and slender, ribbon-shaped, bent backwards and outwards. The coxæ are represented by their basal expansions only, the cylindrical part missing altogether and the telopodites articu-

lating on the inner angles of the basal expansions. The following joints show the normal structure of the ambulatory legs. The vulvar vestibulum is a wide depression closed by five folds made of tough membrane; of these, two anterior symmetrical folds (1, 2) run parallel with the basal expansions of the coxæ, while two lateral symmetrical folds (3, 4) connected by a fifth median odd fold (5) surround the aperture backwards. On each side of the vestibulum are deep invaginations (*i*) in which the vulvæ are concealed.

In *Paraiulus* the conditions change according to the groups, *tiganus* namely being strikingly different from the other species in respect of vulvæ, and until more material has been examined, no general diagram can be proposed. It seems, however, that the vulvar vestibulum is less developed, that the vulvæ are never hidden in independent invaginations and stand side by side on the middle line, and that the limbs of the second pair have always undergone a more or less advanced reduction, disappearing even entirely in some cases (*immaculatus*-*pennsylvanicus*).

In a larval stage of *Paraiulus*, supposed to be the last, the second pair of legs constantly has been found to exist, (Figs. 19, 20), but it differs from the ambulatory legs in that the basal coxal expansion is narrower and the cylindrical part is longer than usual.

Genus **Paeromopus** Karsch, 1881.

**Paeromopus lysiopetalinus** Karsch, 1881.

(Fig. I and 1-5).

♀. Length 133 mm.; diameter 7.25 mm.; 75 segments, of which 1 apodous; 143 pairs of legs.—Adult.

♀. Length 142 mm.; diameter 7.96 mm.; 73 segments, of which 1 apodous; 139 pairs of legs.—Adult.

♀. Length 144 mm.; diameter 6.80 mm.; 73 segments, of which 2 apodous; 137 pairs of legs.—Adult.

Sonoma County, California.

These specimens do not entirely agree with Karsch's description; the fact that the type is a large male, measuring 150 mm. with 80 body segments, may account for the discrepancies.

Color a very dark brown, with brownish limbs; clypeus fulvous; metazonites adorned between the pores with orange transverse bands. Body narrowed anteriorly, the diameter of the seventh segment being 5.20 mm., that of the 24th segment 6.80 mm. Yet the second and third are more swollen than the neighboring segments.

Clypeus transversely wrinkled or rugose. Antennæ reaching as far back as the fifth segment; comparative measures of the joints as follows:

1st joint, length.....	0.559 mm.;	
2d joint, length.....	1.978 mm.;	diameter..... 0.752 mm.
3d joint, length.....	2.193 mm.;	diameter..... 0.709 mm.
4th joint, length.....	1.935 mm.;	diameter..... 0.623 mm.
5th joint, length.....	1.763 mm.;	diameter..... 0.645 mm.
6th joint, length.....	1.333 mm.;	diameter..... 0.645 mm.
7th-8th joints, length.....	0.301 mm.	

Total length..... 10.062 mm.

Mandibular stipe short, scarcely longer than the cardo (Fig. 1); mandibula much higher than broad, with numerous pectinate lamellæ (12 to 14). Intermentum present, divided; postmentum wanting, the gula showing a single ventral ridge, (Fig. 1).

First segment coarsely punctured dorsally; lateral lobes small, acute, with some 8 or 10 thin, shortened sulci closely packed together in the angle of the lobe. Second segment showing coarse punctures intermingled with faint longitudinal sulci dorsally, the punctures disappearing laterally, while the sulci grow deeper. Following segments distinctly sulcate even dorsally, with only few punctures along the posterior margin, the latter disappearing gradually backwards. First pore on the sixth segment, opening in front of, but close to the suture; further caudad the pores open behind the suture in the center of a small, smooth, indistinctly raised area. Segments without marginal fringe. Karsch devotes a special mention to some depressions to be seen on the segments behind the 18th, which have not been observed.

Legs of the first and second pairs comparatively short. First sternal plate membranous; coxæ of first pair expanded laterally with a slightly sinuous outer margin, and without a cylindrical apical part (Fig. 2). Second sternal plate scarcely chitinised between the stigmatic membranous dimples; tracheal stalks very long and slender, ribbon-shaped; coxæ of second pair similar to those of the first, but somewhat shorter.

Vulvæ concealed in lateral, broad and moderately elongate, invaginations, their summit being on a level with the bottom of the vestibulum (Fig. 3). The operculum, in its anterior aspect, appears as a triangular plate strewn with short setæ, the lateral margins of which are bent back perpendicularly, the outer more than the inner. It is tipped with a peculiar, hood-like appendage (*c*, Figs. 4, 5), laterally compressed, overlapping the mound and bearing few setæ.

The mound is protected laterally by oval valves moderately pilose, standing vertically (*ov*). Their upper angles are connected by what appears to be (in posterior aspect) a thick, strongly chitinised, quadrangular pad (*h*), which is the basal end of the horseshoe plate. The upper forks of the latter, as well as the ridge lying between them, are bent forwards so as to face the concavity of the operculum, thus assuming the position of the anterior truncation. The ridge is wide,



lobed cephalad, and divided by a slit which is narrow anteriorly, but abruptly widens backwards. The apodematic gutter (*a*) is moderately elongate and bears numerous loops and two apical, small, globular diverticula (*d*).

The space left free between the valves and behind the horseshoe plate is filled by a plain, subquadrangular plate (*s*) somewhat broader than long and slightly convex, equivalent to the shield of some *Polydesmus*; its upper margin slightly encroaches on the posterior margin of the horseshoe plate, but does not seem fit to cover completely the plate.

***Paeromopus chamberlini*, n. sp.**

(Fig. 6-9).

♀. Length about 84 mm.; diameter 5.10 mm.; 68 segments of which 2 apodous; 127 pairs of legs.—Adult.

Mt. Shasta, California.

Resembles the preceding species in many features such as relative length of the clypeus and of the antennæ, structure of the gnathochilarium, of the anterior body segments, of the first pair of legs, etc.\*

The mandibular stipe is not much longer than the cardo (Fig. 6); it is gradually narrowed anteriorly, the apical angle being slightly produced and acute.

Lateral expansions of the coxæ of second pair much developed (Fig. 7), strongly and evenly arched. The cylindrical part entirely missing. The posterior surface is unusually callous paramesally (*v*) and strongly projects backwards, hanging over the aperture of the vestibulum. The vulvæ appear spindle-shaped on the whole (Fig. 8), being more restricted proximally than in *lysiopetalinus*. The main body of the operculum show no special structure, but the hood (*b*) is larger and broader, more sharpened apically and more expanded caudad, made to cover entirely the mound. The latter (Fig. 9) is longer than high, the valves are lower and more rounded, the horseshoe plate and the ridge are less bent forwards, more horizontal and only partly encroach upon the anterior truncation. The horseshoe plate (*h*) being angularly excised, the ridge is triangular; the slit is not broadened caudad. The apodematic gutter is rather short, depressed in the middle, provided with two short diverticula (*d*); the anterior diverticulum is irregularly swollen and sitting, while the posterior is globular and borne on a short, slender stalk.

The shield (*s*) is as broad as the mound, strongly convex, with rounded base and straight distal margin. The membranous connection between the shield and the horseshoe plate being wide, the shield is admitted to glide over the mound and join the hood of the operculum, the ridge thus becoming entirely hidden from view.

\* Further details to be found in the description of the male given "in fine."

Genus *Paraiulus* Humbert & Saussure, 1869.

*Paraiulus tiganus* Chamberlin, 1910.

(Figs. II and 10-21).

♀. Length 37 mm.; diameter 2.44 mm.; 56 segments, of which 2 apodous; 102 pairs of legs.—Adult.

♀. Length (?); diameter 2.48 mm.; 55 segments, of which 2 apodous; 100 pairs of legs.—Adult.

♀. Length (?); diameter 2.44 mm.; 55 segments, of which 2 apodous; 100 pairs of legs.—Adult.

♀. Length 39 mm.; diameter 2.38 mm.; 54 segments, of which 2 apodous; 98 pairs of legs.—Adult.

♀. Length 29 mm.; diameter 2.05 mm.; 52 segments, of which 2 apodous; 94 pairs of legs.\*—Immature.

*Adult Female*.—Interocular sulcus deeply impressed. Antennæ moderately elongate; comparative measures of joints as follows:

1st joint, length.....	0.192 mm ;
2d joint, length.....	0.608 mm.; diameter.....0.224 mm.
3rd joint, length.....	0.544 mm.; diameter.....0.240 mm.
4th joint, length.....	0.512 mm.; diameter.....0.240 mm.
5th joint, length.....	0.480 mm.; diameter.....0.288 mm.
6th joint, length.....	0.448 mm.; diameter.....0.272 mm.
7th-8th joint, length.....	0.192 mm.

Total length.....2.976 mm..

Mandibular cardo (Fig. 13) equal to two-thirds of the stipe. Mandibular stipe short and broad (ratio: l. 6 x b. 5), rounded anteriorly. Prementum entirely dividing the laminae linguales; the latter bear six setæ in a longitudinal row, besides the usual premarginal bristle.

Second and third segments (Figs. 10, 11) conspicuously swollen. Profile of second segment angular; ventral ridges low (Fig. 13), almost regularly curved; dimples oval, broader than long; ventral lobes large, over-lapping each other. Third segment tapering ventrally, with profile scarcely convex. Anterior aspect as in Fig. 13, B.

Legs of second pair much reduced (Fig. 14). The sternite (*S*) is a short but broad stripe, with posterior margin straight and outer angles unusually produced. Tracheal stalks more or less developed. The six joints of the limbs are preserved, all except the two distal joints being shorter than broad; first joint almost completely fused with the sternal plate; last joint oval, tipped with a spine-like claw.

Vulvar vestibulum moderately deep, with a wide aperture not constricted by symmetrical folds, fastened to the duplicatures of the third segment and to the anterior margin of the fourth. The vulvæ sit at the bottom of the vestibulum side by side, the operculum facing externally and somewhat forwards.

The mound is a very low, semi-cylindrical body, the walls of which represent the horseshoe plate probably fused with the valves (Figs. 15, 18). The inner region of the wall is more raised and more convex than the outer, causing the mound to be asymmetrical, with the ridge

\* The last leg-bearing segment has but a single pair of limbs.

gently sloping outwardly. An abbreviated sulcus is seen on each side of the wall, running close to, and parallel with the anterior truncation, which is rather broad. The apodema (*a*) does not exceed the second third of the ridge; it is deeper in the middle than at both ends and sends forth a median, club-shaped, and an apical, strangely hooked diverticulum (*d*, Fig. 15, 18). The operculum (*O*) is a quite unimportant plate, the form of which is not even definite, as in one of the specimens examined it was scarcely chitinised, while in another no trace of chitinisation could be observed, the operculum being represented by a soft membranous fold.

*Immature Female*.—In an immature female (Fig. 19, 21), the sternal plate of the second pair of legs is three times broader than long in the middle, slightly arched, with the median angle scarcely produced. The immature vulvæ (*W*, Fig. 19) sit on a membrane stretched behind the second pair of limbs, on a level with the laterally reflexed ends of the sternite. Each vulva is formed of three rounded swellings disposed diagonally, the anterior-outer swelling (*O*, Fig. 21) being the operculum, the anterior-inner (*iv*) representing the inner half of the mound, and the posterior (*ov*) the outer half. A rudimentary conic apodema (*a*) is to be observed between the two last mentioned swellings.

It is well worth insisting upon the features of the vulvæ of *P. tiganus*, as not only the condition of the operculum is decidedly exceptional, having never been met with before, but the aspect of the whole organ is so different from what will be found in the following species, that the relationship between the latter and *tiganus* appear very distant, as far as vulvæ are concerned.

#### *Paraiulus pennsylvanicus* (Brandt, 1840), Wood, 1865.

(Fig. 22-27).

♀. Length 39 mm.; diameter 2.25 mm.; 64 segments, of which 2 apodous; 118 pairs of legs.—Adult.

♀. Length 34 mm.; diameter 2.15 mm.; 60 segments, of which 2 apodous; 110 pairs of legs.—Adult.

Interocular sulcus moderately impressed. Mandibular cardo (Fig. 24), shorter than in *P. tiganus*, about two-fifths of the length of the stipe. Breadth of the stipe equal to two-thirds of its length; anterior and ventral edges unite in an evenly curved line without any trace of an anterior angle. The promentum thins out apically, the laminae linguales being almost in contact; the latter bear a row of three to four short setae and two premarginal long bristles.

Anterior body segments almost cylindrical, the diameter of the second segment is only a little larger than that of the head (Fig. 22, 23). Profile of the second segment rounded; ventral ridges raised; dimples more or less angular and subquadrate (Fig. 25, *A*); ventral lobes broad, encroaching on each other. The third segment is not shortened

ventrally; the inner pleural margins are thickened; to their posterior angles are attached flattened lobes, twisted perpendicularly, which overlap each other; the anterior angles are produced into strongly chitinised hooks bent dorsally (Fig. 25, *B*). The upper ends of the hooks are connected by a tough membrane, stretched perpendicularly, in the middle of which are found the relics of the atrophied sternite of the second pair of legs (*P2*). These relics consist of a subreniform, irregularly chitinised, transverse plate, with no definite outline, showing traces of stigmata and of tracheal stalks; the limbs have disappeared altogether.

The space left between the membrane and the ventral lobes is filled with vulvæ. The vestibulum could not be observed, being probably shallow. The vulvæ stand side by side, connected by soft membrane, with the operculum facing cephalad. The general appearance of a vulva is that of a truncate spindle or of a tiny cask. The operculum is flattened, oval in outline, and bears macrochaetae disposed in four longitudinal rows, two lateral and two paramedian rows, the latter converging proximally. The valves (*iv*, Fig. 26), are almond-shaped, with a median row of bristles, and stand erect. The central part of the mound, i. e., the horseshoe plate and the ridge framed by its branches, are strictly comparable to the mound of *tiganus*, which would have undergone a caudal rotation of  $45^\circ$ , causing the ridge to face fully backwards (Fig. 27). Ridge oval. The slit divides the summit of the mound and part of the ridge into fairly symmetrical halves. The apodema is short, but ends in an extremely long, slightly sinuous, tubular diverticulum.

### *Paraiulus immaculatus* Wood, 1864.

(Fig. 28-34).

♀. Length 36 mm.; diameter 2.65 mm.; 51 segments, of which 2 apodous; 92 pairs of legs.—Adult.

♀. Length 31 mm.; diameter 2.10 mm.; 51 segments, of which 2 apodous; 92 pairs of legs.—Adult.

Interocular sulcus not impressed. Antennæ moderately long, not exceeding the fourth segment; comparative measures of joints as below:

1st joint, length.....	0.160 mm.;
2d joint, length.....	0.544 mm.;
3d joint, length.....	0.480 mm.;
4th joint, length.....	0.448 mm.;
5th joint, length.....	0.416 mm.; diameter.....0.208 mm.
6th joint, length.....	0.352 mm.; diameter.....0.224 mm.
7th-8th joint, length.....	0.128 mm.

Total length.....2.528 mm.

Mandibular cardo (Fig. 30) about equal to three-fourths of the stipe, the latter being longer than usual, and rounded anteriorly. Mandibula furnished with 8 to 9 pectinate lamellæ. Promentum

narrow, shorter than the laminae linguales, the inner angles of which are almost in contact. Each lamina bears two setae and two pre-marginal bristles.

Anterior segments not obviously swollen (Figs. 28, 29). Ventral region of second and third segments produced far beyond the collum. Second segment with posterior margin raised and abruptly excised, and with short, triangular ventral lobes. Ventral ridge strong, almost angularly bent; the dimples are broader than long and stretched diagonally (Fig. 31, A). The third segment is not narrowed ventrally; its pleural margins are excised, the posterior angles ending into short, ventral lobes, the apex of which remain separated by a wide gap (Fig. 29). The anterior angles send forth rounded processes which are connected by a chitinous bridge (*P2*), homologous with the sternite of the second pair of legs. The sternal bridge shows traces of the stigmata and of the tracheal stalks, the limbs being completely atrophied.

The sternal bridge, the pleural excision and the ventral lobes of the second segment circumscribe an oval space through which the summit of the vulvae is seen to protrude. Wood (1865, p. 200, Fig. 33) has given a drawing of the vulvae of *immaculatus*, which gives a correct idea of their general aspect. The vulvae stand side by side and cling together, although no fusion seems to intervene (Fig. 32). The operculum is a thick, subquadrangular plate, more than twice as high as broad, with blunt angles; the bristles of the anterior surface are rare and only to be found near the apical margin. On its posterior surface a thickening is seen adjacent to the inner distal angle and projecting above the ridge of the mound (*H*, Figs. 32, 33). The latter is extremely asymmetrical. Seen in posterior aspect, the outer valve (*ov*) appears as a triangular plate gradually narrowed proximally and truncate distally, the distal margin being about half the length of the plate; it leans inwardly so as to cover most of the posterior surface of the organ. The inner valve (*iv*) is more like a subcylindrical pillar, much lower than the outer valve; yet its base being on a level with the center of the outer valve, its summit considerably exceeds the apical truncation of the latter and almost reaches the top of the operculum. No horse-shoe plate is present, unless an apical thickening of the outer valve, which connects it with the inner valve, be considered to be its homologue. The ridge is hidden to view, being bent cephalad and dipping obliquely towards the base of the organ (Fig. 34). The apodema is very short and sends forth a comparatively small, pear-shaped diverticulum.

The sternal plate of the third pair of legs has a special shape, different from that of the other segments in having the anterior angles produced laterally and the sides sinuous.

It is noteworthy that, in *immaculatus*, conditions are similar to those met with in *tiganus*, in so far as the vulvar chamber has a rigid aperture supplied by the third segment. However, the comparison cannot be carried on any further as the vulvae

widely differ in both species, *immaculatus* more approaching those hereafter dealt with. In spite of the special form of its mound, the relationship can be traced in the structure of the operculum, the subapical thickening of which is undoubtedly a preliminary stage of the heart-shaped projection of the synoperculum of *impressus*.

### Paraiulus impressus Say, 1821.

(Fig. 35-42).

♀. Length 33 mm.; diameter 2.20 mm.; 53 segments, of which 2 apodous; 96 pairs of legs.—Adult.

♀. Length 26 mm.; diameter 1.77 mm.; 53 segments, of which 3 apodous; 95 pairs of legs.—Immature.

♀. Length 25 mm.; diameter 1.78 mm.; 53 segments, of which 3 apodous; 95 pairs of legs.—Immature.

*Adult Female*.—Interocular sulcus slightly depressed. Antennæ about the same length as in *immaculatus*, but comparative measures of joints somewhat different:

1st joint, length.....	0.160 mm.;
2d joint, length.....	0.576 mm.;
3d joint, length.....	0.512 mm.; diameter.....0.208 mm.
4th joint, length.....	0.448 mm.; diameter.....0.208 mm.
5th joint, length.....	0.480 mm.; diameter.....0.240 mm.
6th joint, length.....	0.416 mm.; diameter.....0.256 mm.
7th-8th joint, length.....	0.128 mm.
Total length.....	2.720 mm.

Gnathochilarium as in *tiganus*, but less narrowed proximally (Fig. 38); laminae linguales bearing three setæ besides the premarginal pair. Mandibular cardo about two-thirds of the stipe; breadth of mandibular stipe about four-fifths of its length; anterior margin truncate, with lower angle obvious (Fig. 35).

Second and third segments much swollen (Figs. 35, 36), their ventral surface protruding far beyond the angles of the collum and appearing rounded in profile. Ventral ridge of second segment less sinuous than in the preceding species; dimples as high as broad, almost triangular; the ventral lobes remain disjoined (Fig. 37, A). Third segment growing longer ventrally; inner margins almost straight, converging backwards, with rounded anterior angles and short ventral lobes, reflexed and prominent. Ventral aperture wide, filled by the vulvæ, which are never completely concealed (except in contracted condition of the animal).

A rough sketch has already been given in the preceding chapter. The synoperculum sits on a broad base and is narrowed distally, its apical margin being equal to about half its base (Figs. 39, 40). The dwarfed legs of the second pair (*P*2) are attached to its anterior surface, no sternal plate being recognizable; the legs are composed of six joints

shorter than broad, their apex not overreaching the distal margin of the synoperculum. The latter is interrupted mesad, the notch being comparatively narrow and shallow. The heart-shaped projection (*H*, Fig. 40) is slightly impressed longitudinally in connection with the notch; its lateral edges are attenuate and unite proximally with a low, flattened, perpendicular keel, dividing the basal excavations.

The mound (Figs. 40, 41) is a globular, asymmetrical body, entirely clad with the valves, which are fused with the horse-shoe plate and only connected caudad by a narrow, not particularly chitinised bridge. The inner valve is the longest; it is inflated caudad, its upper margin being feebly lobed; cephalad is a low, sharpened, diagonal crest (*c*). The outer valve is divided anteriorly by a wide perpendicular furrow (*w*), the bottom of which is membranous, the valve being conspicuously gibbous immediately backwards of the furrow. The upper margins of the valves are pressed together, concealing the ridge. The apodemetic gutter (*a*, Fig. 41) is located in the anterior half of the mound; it appears distorted by numerous loops and terminates in a long and comparatively thick, gradually tapering diverticulum.

Ventral region of the fourth segment, as in Fig. 37, *B*.

*Immature Female.*—In a larva of the last stage, the mandibular stipe is gently narrowed anteriorly and rounded apically. The second and third segments are neither swollen nor produced ventrad; the third is very different from what it is in adult and more approaches the condition of the second segment, being even shorter than the latter. The main points of the structure of the second pair of legs have already been recorded.

The immature vulvæ (Fig. 42) are considerably more developed than in the *tiganus* larva, being broader than the second sternite, and several details being noticeable. The opercula have already coalesced, their evenly arched upper margins uniting mesad and giving rise to a wide angular notch; on each side of the notch the posterior surface of the synoperculum shows the raised area which, in the adult organ, will be fused in a heart-shaped projection. The mounds are broader than high and of comparatively much larger size than in the adult; yet no other detail of their structure is obvious but a rudimentary apodemetic thickening.

### *Paraiulus venustus* Wood, 1864.

(Fig. 43-50).

♀. Length 33 mm.; diameter 2.45 mm.; 51 segments, of which 2 apodous; 92 pairs of legs.—Adult.

♀. Length 33 mm.; diameter 2.42 mm.; 50 segments, of which 2 apodous; 90 pairs of legs.—Adult.

♀. Length 25 mm.; diameter 2.05 mm.; 51 segments, of which 2 apodous; 93 pairs of legs.—Immature.

*Adult Female*.—Resembles *impressus* in most of its features. Antennæ as below:

1st joint, length.....	0.224 mm.;	
2d joint, length.....	0.544 mm.;	diameter.....0.208 mm.
3d joint, length.....	0.512 mm.;	diameter.....0.208 mm.
4th joint, length.....	0.448 mm.;	diameter.....0.208 mm.
5th joint, length.....	0.448 mm.;	diameter.....0.240 mm.
6th joint, length.....	0.432 mm.;	diameter.....0.256 mm.
7th-8th joint, length.....	0.096 mm.	
Total length.....		2.704 mm.

Mandibular stipe truncate, but scarcely angular below. Lateral lobes of first segment not evenly rounded, a posterior angle being obvious. The second and third segments are appreciably more swollen, in relation with the larger size of the vulvæ (Figs. 43, 44). The posterior ventral margin of the second segment is raised and rounded, causing the ventral dimple to be almost as long as broad, trapeziform (Fig. 45, A). The third segment is much longer ventrally than dorsally; the inner pleural margins are parallel and nearly straight; but the ventral lobes are so small and so widely separated that the vulvar aperture is practically open backwards and reaches as far back as the fourth segment, (Fig. 44).

The vulvæ are uncommonly large (Fig. 46, 47). H. C. Wood (1865, p. 197, Fig. 29) has issued a description and a drawing of these organs which, though reduced are perfectly appropriate; yet he fails to mention that the "flattened cylinders" are coalesced. Compared with the similar organ of *impressus*, the synoperculum is more quadrate, its outer margins being perpendicular (slightly emarginate) and its breadth hardly different distally and proximally. The median notch is larger, with rounded bottom. The edges of the heart-shaped projection (H, Fig. 47) are considerably expanded into broad, flattened triangular lobes, reaching laterally the outer margins of the synoperculum and overlapping the distal half of the excavations in which the mounds are sheltered; the outer margins of the lobes converge towards the base of the synoperculum without meeting, entirely disjoining the mounds.

The "pair of very slender, almost filiform, feet-like bodies" mentioned by Wood in connection with the synoperculum, are the atrophied limbs of the second pair which are fastened to its anterior surface. As in *impressus* the six joints are preserved, being broader than long and of irregular size. In addition a small sternal plate was present in the specimen examined.

The lateral outline of the mound reminds of a crescent, the lower, rounded end of which is abruptly bent inwardly below the mound (Fig. 48). A narrow cleft divides the organ into two subequal halves, which are only connected caudad by the reflexed end of the crescent (h, Fig. 49), this being equivalent to the horse-shoe. No dividing sulcus exist between the latter and the valves. Cephalad each valve bears a sharp diagonal crest, both crests meeting at the anterior end of the crescent. The anterior region of the inner valve which faces



the synoperculum is poorly chitinized, but lacks the furrow observed in *impressus*. The apodematic gutter (*a*) is by one-third shorter than the mound; it appears distorted by numerous, densely packed loops and terminates caudad with a long, rod-like diverticulum, bent at right angles near its base and clavately enlarged apically (*d*).

The sternite of the third pair of legs is unusually widened cephalad, its breadth largely exceeding half the diameter of the segment (Fig. 45, *B*).

*Immature Female*.—In a larva admitted to belong to the last stage, the mandibular stipe is rounded in front, no trace of inferior angle being obvious. The second segment has its ventral margins less produced. The third is quite different from the corresponding mature segment, as it is gradually narrowed ventrally, the inner margins running obliquely in the lobes, very much as in the second segment. The second pair of limbs is unmodified, i. e., it shows the structure of the ambulatory legs, except that the coxæ are longer, as is the case with larvæ of other species.

The immature vulvæ (Fig. 50) remind of those of *impressus*, as the opercula are low, transverse plates, with distal margin gently arched, but not fused mesad. The mounds appear as half-moon-shaped bodies, divided by a shallow depression, with a linear slit and rudiments of the horse-shoe and of a digitiform diverticulum.

#### *Paraiulus ellipticus* Bollman, 1887.

(Brolemann, 1896-1902).\* (Figs. 51, 52).

Gnathochilarium as in *pennsylvanicus*. The twisted ventral lobes of the third segment are very prominent ventrad. A rough outline of the anterior aspect of same and of one of the limbs of the second pair has been published in 1902. Traces of the second sternite are preserved.

Synoperculum very deeply split mesad (Fig. 51); on each side the distal margin is slightly curved and sloping laterally, being in addition strewn with tiny setæ. Lateral margins sinuate, prominent at a short distance from the base. Heart-shaped projection (*H*) somewhat as in *venustus*, its edges being likewise expanded into flattened lobes, but the latter remaining far apart from the outer margins of the synoperculum; the lobes converge abruptly, uniting in a ploughshare-like process (*x*) bent cephalad and driven between the summit of the mounds (*M*), the bases of which remain in contact. The valves of the mound are very dissimilar, the outer (*ov*, Fig. 52) being somewhat higher and appreciably shorter than the inner, causing the ridge to face obliquely backwards and externally. The ridge (*r*) is wide and divided by a conspicuous slit. The apodematic gutter is comparatively short, dipping perpendicularly, provided with some rounded loops and with a fairly long diverticulum, much as in *venustus*.

\* This specimen being no longer in the author's collection, the secondary structures had to be omitted.

## DESCRIPTION OF A NEW SPECIES.

**Paeromopus chamberlini** n. sp.

(Figs. 53-57).

♂. Length about 111 mm.; diameter 4.60 mm.; 79 segments, of which 1 apodous; 149 pairs of legs.—Adult.

♂. Length about 93 mm.; diameter 5.12 mm.; 71 segments, of which 2 apodous; 131 pairs of legs.—Adult.

Mount Shasta, California.

Pleural regions black, or at least very dark brown; a broad lively orange band runs dorsally from the first tergite to the last, almost entirely filling the space between the pores; the band thins out anteriorly; posteriorly it covers the margins of the anal valves. Clypeus fulvous, with yellow margin. Limbs brownish.

Labral plate very obvious, the anterior margin of the clypeus being somewhat swollen; mesal notch deep. Clypeus elongate, almost three times the length of the epicranium; surface rather flattened, leathery, with but few setiferous punctures, of which a pair stands in a line with the antennæ. Epicranium unusually short, longitudinally rugose, divided by a distinct sulcus. A less marked transverse sulcus connects the inner angles of the eyes; behind, and in contact with it is the usual pair of setiferous dimples which is formed by coupled punctures. Antennæ long, yet not extending over the fourth segment; measures of joints as below:

1st joint, length.....	0.256 mm.;
2d joint, length.....	1.344 mm.; diameter..... 0.544 mm.
3d joint, length.....	1.728 mm.; diameter..... 0.544 mm.
4th joint, length.....	1.440 mm.; diameter..... 0.448 mm.
5th joint, length.....	1.374 mm.; diameter..... 0.480 mm.
6th joint, length.....	1.184 mm.; diameter..... 0.480 mm.
7th-8th joint, length.....	0.192 mm.

Total length..... 7.518 mm.

Ocelli distinct, numbering about 22 (7, 6, 5, 4), collected on a subtriangular field. Mandibular stipe (Fig. 53) almost quadrate, not longer than high, produced ventrally and with its anterior angle somewhat angular. Gnathochilarium as in female *lysiopetalinus*, i. e., with intermentum and without postmentum.

Collum strewn dorsally with numerous, moderately coarse punctures. Lobes small, angular, marked with four or five short and thin sulci. Following segments very much as in *lysiopetalinus*, the metazonites bearing sulci intermingled with punctures; sulci strongly impressed anteriorly, less deep but more numerous backwards. First pore on the sixth segment; the five or six anterior pores are located behind, and in contact with the suture, which is slightly sinuous; further caudad the pores and more and more removed from the suture, so as to open in the first and third of the metazonite. Last tergite very short; its posterior margin is thick and scarcely produced, leaving uncovered the

dorsal angles of the anal valves. The latter are moderately prominent, much higher than long, scarcely rugose, with a tiny irregular sulcus close to the inner margin. Anal sternite with apex truncate. Sternites with a transverse groove behind the middle. Legs elongate; the ventral surface of the second joint is fleshy, appearing generally excavated, and the fifth joint is provided with an angularly produced pad, both structures being found on almost all the legs.

The legs of the first pair are not unlike those of *lysiopetalinus* (Fig. 55). The basal joint is a very short ring, curiously excised posteriorly (*C*), provided with a short tracheal stalk; outwardly a small rounded plate is seen (*S*), admitted to be all that is left of the sternite, the first joint thus being a coxa. The second joint is still shorter and open externally. The remaining joints of the limb are fused into a short and stout cone, tipped with a hook coiled cephalad and divided on its posterior surface by two superficial transverse sulci, which do not extend on the opposite surface. Legs of the second pair with almost completely atrophied sternite; coxal joint subcylindrical, destitute of basal expansion. The following joints show no particular structures, the telopodite being merely shorter than in the ambulatory legs. Penis small, parallel sided on most of its length, apically divided into a pair of abruptly sharpened cones.

Peltogonopods (i. e., anterior pair of gonopods, Fig. 56) resembling those of *lysiopetalinus*. The very short sternal band (*S*) is fused with the long and flattened tracheal stalks (*t*). Coxal joint very long (*C*), gently tapering distally, its apex being pear-shaped and provided with two small hooks directed cephalad. The basal half of its inner edge bears an inconspicuous, short and blunt, retroflexed projection. Apical joint (*T*) as long as the coxa, fastened to the lateral edge of the latter in a manner that its basal, narrowed end almost reaches the sternal plate, while its distal end exceeds the summit of the coxa by less than one-fourth of its own length. The distal end is shallowly depressed cephalad, with acute outer angle, and is provided with two conspicuous processes, an anterior very long and slender, stake-like process, the sharpened end of which is directed proximally, and an inner erected, slightly curved spine, expanded and toothed in the middle of its length.

Sternite of gonopods (*S*, Fig. 57) crescent-shaped, with a narrow median, erected rod thrust between the limbs. The latter are rectangular lamellæ, three times as long as broad. Above the very thick base, the anterior surface is abruptly and deeply excavated, and the outer margin is slightly notched, owing to the fact that the distal part of the margin lies over the proximal part instead of standing in a line with it. Such structures bearing evidence to the former existence of a joint, the proximal thickened region (*C*) has to be looked upon as a coxal ring, while the upper flattened region (*T*) is equivalent to a telopodite. The latter end with a shallow depression, the outer angle being rounded and the inner bearing two short, erected processes, an anterior hooked and an inner spined process. The presence of a seminal groove could not be ascertained.

The female structures have been described above. The larval stages are unknown.

The systematic position of the genus *Pæromopus* has long remained doubtful. Its features are so special that Bollman has been led to create for it the family *Pæromopidæ*, in which Karsch's genus stood alone. But the question of its affinities was not solved thereby. Silvestri, after having left the point undecided, 1896<sup>1</sup>, finally, 1898, admits Bollman's family *Pæromopidæ* amongst his *Iuloidea*. So likewise does Pocock<sup>2</sup> who denies it a relationship with the *Blaniulidæ* and the *Isobatidæ*. Attems, in his arrangement of the so-called "*Protoiulidæ*," does not mention Karsch's genus<sup>3</sup>.

That *Pæromopus* has to take place in the *Paraiulidi* phylum, will certainly not be contested; yet it has still to be decided if it has to stand with the *Paraiulidæ* or with the *Blaniulidæ*<sup>4</sup>.

If considered separately, the male genitalia supply no positive criterium. However, since the vulvæ are somewhat better known, it seems that a clue may be obtained from their structure. It has been mentioned that the vulvæ of *Pæromopus*, provided as they are with a shield, are of a type not usually met with amongst *Iuloidea*. In fact the only species in which a similar structure has been as yet observed, is *Mesoblaniulus serrula* (Brol.), a tiny cave-dweller of the French Mediterranean coast, originally ascribed to *Blaniulus*. In a paper actually submitted to press<sup>5</sup>, an abstract of which<sup>6</sup> appeared recently, the author has altered his first opinion mostly on account of the conditions of the vulvæ; consequently it has been brought to rank amongst the *Isobatinæ*. An identical reason will therefore justify an attempt to enclose *Pæromopus* in the same group, in which a new Tribe—*Pæremopini*—will have to be created for its reception. No objection against such a conclusion can be derived from the male genitalia of *Pæromopus*, as these show the structure constantly found existing in *Isobatinæ*, i. e., the preservation in the gonopods of a distinct coxal region, which is missing in *Blaniulinæ*.

<sup>1</sup>Silvestri, 1896, Ann. Mus. Civ. Stor. Nat. Genova, (ser. 2) XVI, 26, III, 1896, and 1898, Ibid, (ser. 2) XVIII, 29 XII, 1897.

<sup>2</sup>Pocock, Ann. Mag. Nat. Hist., (7) XII, No. 71, Nov. 1903, p. 527.

<sup>3</sup>Attems, Arkiv. for Zool., Stockholm, 1909, V, No. 3.

<sup>4</sup>According to the author's system, the *Blaniulidæ* are divided into two sub-families, *Blaniulinæ* and *Isobatinæ*.

<sup>5</sup>This paper was ended during the spring, 1921, but could not be issued owing to the adverse conditions.

<sup>6</sup>Arch. Zool. exper. gen., LX, Notes et Revue, No. 1, 1921.

Of course the point under discussion will have to be re-examined when the American *Isobatinae* and the Asiatic fauna will have become better known. Amongst the Japanese Diplopods already recorded is Attems' genus *Karteroiulus*, the male of which has the fourth segment open, whereas it is fused with the corresponding sternite in the female. But judging from the rough outline published by Attems (l. c., Pl. 2, Fig. 34), the vulvæ seem more closely related to those of the *impressus* group, as the "auf der Oralseite aufgeschlitzten Chitinring" probably answers halves of the synoperculum described in the preceding pages. Nothing is known of the female *Kopidoiulus* Att., the male of which is said to have the fourth segment open, as in *Karteroiulus*.

---

#### EXPLANATION OF ABBREVIATIONS USED

<i>a</i> = Apodematic gutter of Mound.	<i>o</i> = oviduct.
<i>b</i> = Hood of operculum.	<i>ov</i> = outer valve of Mound.
<i>C</i> = Coxite.	<i>P2, P3</i> = Second, third pairs of limbs.
<i>d</i> = Diverticulum of Vulvæ.	<i>p</i> = Postmentum.
<i>G</i> = Gula.	<i>R</i> = Stipes of gnathochilarium.
<i>H</i> = Heart-shaped projection of operculum or synoperculum.	<i>r</i> = Ridge of Mound.
<i>h</i> = Horse-shoe plate or thickening of Mound.	<i>S</i> = Sternite.
<i>i</i> = Intermentum.	<i>s</i> = Shield of Vulvæ.
<i>iv</i> = Inner valve of Mound.	<i>T</i> = Telopodite of limbs.
<i>l</i> = Ventral lobes of segments.	<i>T</i> = Tracheal stalks.
<i>M</i> = Mound of vulvæ.	<i>u</i> = Ventral dimples of segments.
<i>O</i> = Operculum of vulvæ.	<i>v</i> = Valves of Mound.
	<i>W</i> = Vulvæ.
	<i>Y</i> = Synoperculum of Vulvæ.

## EXPLANATION OF PLATES.\*

## PLATE XIX.

- Fig. 1. *Paeromopus lysioptetalinus*. Right mandibula, ventral aspect.  
 Fig. 2. *Paeromopus lysioptetalinus*. First pair of limbs, cephalic aspect.  
 Fig. 3. *Paeromopus lysioptetalinus*. Second pair of legs, vestibulum (V), and right vulvar invagination (I), caudal aspect. 1-5=Folds of aperture of vestibulum.  
 Fig. 4. *Paeromopus lysioptetalinus*. Left vulva, caudal aspect.  
 Fig. 5. *Paeromopus lysioptetalinus*. Left vulva, outer profile.  
 Fig. 6. *Paeromopus Chamberlini*. Cardo and stipe of left mandibula, ventral aspect.  
 Fig. 7. *Paeromopus Chamberlini*. Coxæ of second pair of legs of adult female, caudal aspect.  $\gamma$ =paramesal projection of coxæ; 1-5= folds of aperture of vestibulum.  
 Fig. 8. *Paeromopus Chamberlini*. Right adult vulva, caudal aspect.  
 Fig. 9. *Paeromopus Chamberlini*. Mound and shield of right adult vulva, oblique caudal aspect.

## PLATE XX.

- Fig. 10. *Paraiulus tiganus*. Anterior end of adult female.  
 Fig. 11. *Paraiulus tiganus*. Ventral aspect of segments 1-3 of same.  
 Fig. 12. *Paraiulus tiganus*. Cephalic aspect of second segment (A) and ventral region of third (B).  $n$ =ventral ridge, and  $u$ =ventral dimple of 2d segment.  
 Fig. 13. *Paraiulus tiganus*. Cardo and stipe of left mandibula, ventral aspect.  
 Fig. 14. *Paraiulus tiganus*. Legs of second pair of adult female, cephalic aspect.  
 Fig. 15. *Paraiulus tiganus*. Mound of left adult vulva, outer aspect.  $O$ =membranous fold replacing the operculum.  
 Fig. 16. *Paraiulus tiganus*. Left vulva from above.  $O$ =membranous fold replacing the operculum.  
 Fig. 17. *Paraiulus tiganus*. Anterior truncation of left vulva, the opercular fold of which has been removed.  
 Fig. 18. *Paraiulus tiganus*. Left vulva of another adult female, outer aspect, showing individual variations in the diverticulum,  $d$ .

## PLATE XXI.

- Fig. 19. *Paraiulus tiganus*. Legs of second pair of larva and immature vulvæ, caudal aspect.  
 Fig. 20. *Paraiulus tiganus*. Base of legs of second pair of larva, cephalic aspect.  
 Fig. 21. *Paraiulus tiganus*. Immature vulvæ of Fig. 19, enlarged.  
 Fig. 22. *Paraiulus pennsylvanicus*. Anterior end of adult female.  
 Fig. 23. *Paraiulus pennsylvanicus*. Ventral aspect of segments 1-3 of same.  
 Fig. 24. *Paraiulus pennsylvanicus*. Cardo and stipe of left mandibula, ventral aspect.  
 Fig. 25. *Paraiulus pennsylvanicus*. Cephalic aspect of ventral region of second segment (A) and of third (B).  $x$ =membrane connecting the ventral margins of 3d segment and bearing the atrophied sternite of 2d legs,  $P_2$ .  
 Fig. 26. *Paraiulus pennsylvanicus*. Right adult vulva, inner profile.  
 Fig. 27. *Paraiulus pennsylvanicus*. Right adult vulva, caudal aspect.  
 Fig. 28. *Paraiulus immaculatus*. Anterior end of adult female.  
 Fig. 29. *Paraiulus immaculatus*. Ventral aspect of segments 1-3 of same.  $P_2$ =chitinised bridge with symmetrical thickenings homologous to sternite of second pair of legs.

\*Camera drawings from the author.

## PLATE XXII.

- Fig. 30. *Paraiulus immaculatus*. Cardo and stipe of right mandibula, ventral aspect.
- Fig. 31. *Paraiulus immaculatus*. Cephalic aspect of ventral region of second segment (A) and of third (B). *P2*=atrophied sternite of second legs.
- Fig. 32. *Paraiulus immaculatus*. Adult vulvæ, caudal aspect.
- Fig. 33. *Paraiulus immaculatus*. Right vulva, outer profile.
- Fig. 34. *Paraiulus immaculatus*. Inner oblique view on the anterior truncation of left vulva, the operculum of which has been partly detached and turned aside.
- Fig. 35. *Paraiulus impressus*. Anterior end of adult female.
- Fig. 36. *Paraiulus impressus*. Ventral aspect of segments 1-3 of same. *S4*=sternite of 4th segment.
- Fig. 37. *Paraiulus impressus*. Cephalic aspect of ventral region of second segment (A) and of fourth (B). *S4*=sternite of 4th segment.
- Fig. 38. *Paraiulus impressus*. Gnathochilarium of adult female.

## PLATE XXIII.

- Fig. 39. *Paraiulus impressus*. Synoperculum and dwarfed legs of second pair, cephalic aspect.
- Fig. 40. *Paraiulus impressus*. Both vulvæ, caudal aspect. The left mound is bent backwards and is seen from above. *c*=crest of the inner valve of the mound, and *w*=furrow of the outer valve. *e*=basal excavation of the synoperculum.
- Fig. 41. *Paraiulus impressus*. Mound of left vulva, inner profile. *c*=crest of the inner valve.
- Fig. 42. *Paraiulus impressus*. Base of legs of second pair of larva with immature vulvæ, caudal aspect.
- Fig. 43. *Paraiulus venustus*. Anterior end of adult female.
- Fig. 44. *Paraiulus venustus*. Ventral aspect of segments 1-3. *S4*=sternite of fourth segment.
- Fig. 45. *Paraiulus venustus*. Cephalic aspect of ventral region of second segment (A) and of fourth (B). *S4*=sternite of fourth segment.
- Fig. 46. *Paraiulus venustus*. Synoperculum and dwarfed legs of second pair, cephalic aspect. *O*=oviduct.
- Fig. 47. *Paraiulus venustus*. Both vulvæ, caudal aspect. *x*=hardened area in the membrane of the vestibulum.

## PLATE XXIV.

- Fig. 48. *Paraiulus venustus*. Mound of the right vulva, outer profile.
- Fig. 49. *Paraiulus venustus*. Mound of the right vulva, anterior truncation (cephalic aspect).
- Fig. 50. *Paraiulus venustus*. Base of legs of second pair of larva with immature vulvæ, caudal aspect.
- Fig. 51. *Paraiulus ellipticus*. Synoperculum and right mound (*M*), oblique caudal aspect. The left mound has been removed to show the plow-share-like process of the synoperculum, *x*.
- Fig. 52. *Paraiulus ellipticus*. The left mound, outer profile.
- Fig. 53. *Paeromopus Chamberlini*. Cardo and stipe of male left mandibula, ventral aspect.
- Fig. 54. *Paeromopus Chamberlini*. Ventral aspect of segments 1-3 (under contraction).
- Fig. 55. *Paeromopus Chamberlini*. Left leg of first pair of male. *A*=cephalic aspect; *B*=caudal aspect.
- Fig. 56. *Paeromopus Chamberlini*. Right half of peltogonopods, cephalic aspect.
- Fig. 57. *Paeromopus Chamberlini*. Left half of gonopods, cephalic aspect.